REMARKS

Claims 1-7 were pending in the application. Claims 1-7 stand rejected. Claims 1-4 and 7. Claims 8-20 were added. Claims 1-20 remain pending.

Claim 1 is provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claim 1 of copending Application No. 10084006. It is believed that Claim 1, as amended, is patentably distinct from the current claims of the cited reference. Review of the amended claims and the current claims of the cited reference is requested. It is understood that, if the obviousness-type double patenting rejection is made final, the rejection can be overcome with an appropriately filed terminal disclaimer.

Claims 1, 5 and 6 stand rejected under 35 U.S.C. 102(b) as being anticipated by Song (US 5,038,388). Claim 2 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Song in view of Guissin (US 5,442,462). Claims 4 and 7 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Song in view of Guissin, and further in view of Reuman (US 6,069,982).

The rejection states as to Claim 1:

> "Regarding claim 1, Song discloses a method of sharpening a digital image having image pixels according to its noise content, comprising the steps of (Fig. 2):
>
> "a) providing an image sharpener having a variable parameter of sharpening (Equation 6; C*S in the equation correspond to the variable sharpener.),
>
> "b) generating a noisy pixel belief map corresponding spatially to the image pixels having belief values indicating the likelihood that the modulation about respective pixels are due to system noise (Equation 7; V(i,j) generates the noise belief map, where the variance magnitude can indicate the noise belief for a given pixel.); and
>
> "c) using the noisy pixel belief map to vary the parameter of the image sharpener (Equation 7; S is a sharpening coefficient that varies with the noise belief map.)."

Amended Claim 1 states:

> 1. A method of sharpening a digital image having image pixels according to its noise content, comprising the steps of:

generating a noisy pixel belief map corresponding spatially to the image pixels having belief values indicating the likelihood that the modulation about respective pixels are due to system noise, said noisy pixel belief map being based upon both a local noise measure of pixels of the digital image and a noise table separate from said digital image; and

using the noisy pixel belief map to vary a variable parameter of an image sharpener.

Claim 1 is supported by the application as filed, notably the original claims and at page 5, line 28 to page 8, line 15 (particularly see page 7, lines 11-12 and page 8, lines 8-15).

Claim 1 requires that the noisy pixel belief map is based upon <u>both</u> a local noise measure of pixels of the digital image and a noise table that is separate from the digital image. This contrasts with Song, which uses a variance magnitude of the image pixels. (Song, col. 3, lines 33-35) Song does not disclose a noise table, nor does Guissin. Reuman discloses a noise table. The Office Action discussed this in relation to Claims 4 and 7:

> "It would have been obvious to one with ordinary skill in the art at the time of invention to modify the teachings Song and Guissin with Reuman to construct a noise table and calculate the signal to noise ratio from that table. Since, LUTs are common knowledge in the art and one would use them to speed up commonly occurring operations."

This teaches use of an LUT noise table, but, like Song and Guissin, does not teach generating a noisy pixel belief map based upon both a local noise measure of pixels of the digital image and a noise table separate from the digital image.

Claims 2, and 4-9 are allowable as depending from Claim 1 and as follows.

Claims 2 and 4 are supported by the same portions of the original application as Claim 1. (In relation to Claim 4, see page 7, lines 25-26) The rejection argues in relation to Claim 2:

> "Guissin discloses the noisy pixel belief map being derived from the local signal to noise ratios (Col. 4 Lines 9-12; Signal to noise ratios are used to form the belief map, which is used in adaptive weighting for sharpening and smoothing.)" (Office Action, page 5)

Applicants have been unable to locate anything in Guissin that teaches or suggests that the belief map is used for sharpening. Guissin is limited to smoothing.

Added Claim 8 states:

> 8. The method claimed in claim 2, further comprising subsampling said digital image to a predetermined number of subsampling levels.

Claim 8 is supported by the application as filed, notably the original claims and at page 5, line 29 to page 6, line 5 and page 7, lines 25-26.

The rejection states as to Claim 4:

> "Regarding claim 4, Song and Guissin meet the claim limitations as set forth in the discussion for claim 2 and 5.
>
> "Song and Guissin disclose the method with a digital image consisting of two or more channels and generation of noisy pixel belief map (Song Col. 5 Lines 16-28; Guissin Col. 18 Lines 27-31; A color image consists of three channels and the cited art discloses development of noisy pixel belief map generation for color images.). Guissin discloses the calculating of the signal to noise ratio of at least one pixel and computing of the belief map from the signal to noise ratio (Col. 4 Lines 9-12; Signal to noise ratios are used to form the belief map, which is used in adaptive weighting for sharpening and smoothing.).
>
> "However, neither Song nor Guissin disclose the noise table indicating the relationship between pixel intensity and expected noise.
>
> "Reuman discloses the noise table indicating the relationship between pixel intensity and expected noise (Col. 5 Lines 58-62).
>
> "It would have been obvious to one with ordinary skill in the art at the time of invention to modify the teachings Song and Guissin with Reuman to construct a noise table and calculate the signal to noise ratio from that table. Since, LUTs are common knowledge in the art and one would use them to speed up commonly occurring operations."

Claim 4 has been amended to state:

4. The method claimed in claim 8, wherein the digital image includes two or more channels, and the step of generating a noisy pixel belief map comprises the steps of:

calculating a signal to noise ratio for at least one pixel of the digital image, the signal to noise ratio based on: said local variance of the pixels, said noise table, and said number of subsampling levels; and

computing a belief value of the noisy pixel belief map from the signal to noise ratio.

Claim 4 requires that the generating of a noisy pixel belief map includes the step of calculating a signal to noise ratio based on local variance of the pixels <u>and</u> the separate noise table <u>and</u> the number of subsampling levels used in subsampling the digital image. As discussed above in relation to Claims 1 and 2, Song and Guissin do not even teach calculation of a signal based on <u>both</u> local variance and a separate noise table. The rejection cites Vuylsteke et al. in relation to Claim 3 and states:

"Vuylsteke et al. discloses the generation of a noisy pixel belief map from the interpolated low resolution noisy pixel belief map, which is derivede from the low resolution version of the digital image." (Office Action, page 8)

This is not a teaching or suggestion of calculating a signal to noise ratio based on ... the number of subsampling levels used in subsampling the digital image. A combination of the cited references would not disclose or suggest Claim 4.

Claim 3 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Song in view of Vuylsteke et al. (US 5,461,655). The rejection states:

"Song meets the claim limitations as set forth in the discussion for claim 1.

"However, Song does not disclose the generation of a noisy pixel belief map from the interpolated low resolution noisy pixel belief map, which is derived from the low resolution version of the digital image.

"Vuylsteke et al. discloses the generation of a noisy pixel belief map from the interpolated low resolution noisy pixel belief map, which is derived from the low resolution version of the digital image (Col. 7 Lines 37-46; Col. 8 Lines 62-67).

"It would have been obvious to one with ordinary skill in the art at the time of invention to modify the teaching of Song with Vuylsteke et al. to generate the above stated noisy pixel belief map. The computational intensity of low resolution image is lower than that of a detail image. In order to generate the noise belief map using less system resources, one would utilize a low resolution image."

Claim 3 requires generating a low resolution noisy pixel belief map from the low resolution version of the digital image and interpolating the low resolution noisy pixel belief map to produce the noisy pixel belief map. Vuylsteke et al. discloses subsampling then interpolating the digital image itself multiple times:

"A preferred embodiment of the decomposition process is depicted in FIG. 4a. The original image is filtered by means of a low pass filter 41, and subsampled by a factor of two, which is implemented by computing the resulting low resolution approximation image g_1 only at every other pixel position of every alternate row.

"A detail image b_0 at the finest level is obtained by interpolating the low resolution approximation g_1 with doubling of the number of rows and columns, and pixelwise subtracting the interpolated image from the original image 2." (Vuylsteke et al., col. 7, lines 37-46)

This process is repeated to obtain lower resolution images. (Vuylsteke et al., col. 7, lines 53-56) A histogram is generated from the resulting set of images. (Vuylsteke et al., col. 9, lines 3-7; col. 8, lines 39-62) A maximum in that histogram is used as an estimate for the noise variance in the detail image. (Vuylsteke et al., col. 8, lines 62-67) This is unlike the claimed invention.

Added Claims 10-15 are allowable as depending from Claim 3 and as follows.

Claim 10 is supported and allowable on grounds discussed above in relation to Claim 1.

Claim 11 is supported and allowable on grounds discussed above in relation to Claim 2.

Claim 12 is supported on the same basis as Claim 8.

Claim 13 is supported and allowable on the same grounds as Claim 4.

Claims 14-15 are supported by the application as filed, notably the original claims.

Added Claim 16 states:

16. A method of sharpening a digital image having image pixels according to its noise content, comprising the steps of:

subsampling said digital image to a predetermined number of subsampling levels to provide a subsampled image;

generating a noisy pixel belief map from said subsampled image, said noisy pixel belief map being based upon a local noise measure of pixels of the digital image, a noise table separate from said digital image, and said number of subsampling levels;

using the noisy pixel belief map to vary a variable parameter of an image sharpener; and

applying said image sharpener to said digital image.

Claim 16 is supported and allowable on grounds discussed above in relation to Claims 1, 4, and 8.

Claims 17-20 are allowable as depending from Clam 16 and as follows.

Claim 17 is supported and allowable on grounds discussed above in relation to Claim 2.

Claim 18 is supported and allowable on grounds discussed above in relation to Claim 3.

Claim 19 states:

19. The method claimed in claim 18, wherein said noisy pixel belief map maps signal to noise ratios of pixels of the subsampled image, said signal to noise ratios being represented by the equation:

$$\mathrm{SNR}(m,n)=1+\mathrm{sign}[\sigma_n(m,n)^2-\sigma_k(i(m,n))^2]\frac{\sqrt{\left|\sigma_n(m,n)^2-\sigma_k(i(m,n))^2\right|}}{\sigma_k(i(m,n))}$$

wherein:

SNR(m,n) is the signal to noise ratio;

m,n are the coordinates of each pixel;

$\sigma_n(m,n)$ is a standard deviation of pixels of a luminance channel in a window centered on m,n, said luminance channel being a linear combination of a plurality of color channels;

$sign[q]$ is –1 if $q < 0$, otherwise $q = 1$; and

$$\sigma_k(i(m,n)) = \frac{1}{R_f{}^R}\sqrt{\sum_{n=0}^{n=C-1} a_n{}^2(\sigma_{c_n}[c_n(m,n)])^2}$$

for each of said color channels,

wherein:

R is the number of subsampling levels;

$\sigma_{c_n}[q]$ is a standard deviation of noise at intensity q for one of the color channels c_n;

R_f is a constant.

Claim 19 is supported by the application as filed, notably at page 6, line 10 to page 8, line 13. In Claim 19, the equation for the signal to noise ratio includes terms for a local standard deviation of pixels of a luminance channel, the number of subsampling levels, and a standard deviation of noise at intensities in one of the color channels used to produce the luminance channel. This is unlike the cited references.

Claim 20 states:

20. The method claimed in claim 19 wherein R_f is 1.7 and R is less than or equal to 3.

Claim 20 is supported by the application as filed, notably page 8, lines 1-3. Claim 20 is allowable as depending from Claim 19.

It is believed that these changes now make the claims clear and definite and, if there are any problems with these changes, Applicants' attorney would appreciate a telephone call.

In view of the foregoing, it is believed none of the references, taken singly or in combination, disclose the claimed invention. Accordingly, this application is believed to be in condition for allowance, the notice of which is respectfully requested.

Respectfully submitted,

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If the Examiner is unable to reach the Applicant(s) Attorney at the telephone number provided, the Examiner is requested to communicate with Eastman Kodak Company Patent Operations at (585) 477-4656.